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IN REPLY

REFER TO:

H-DO MS881

August 13, 1974

Dr. Martin L. Minthorn, Jr.
Division of Biomedical and
Environmental Research
U. S. Atomic Energy Commission
Washington, D. C. 20545

US DOE ARCHIVES	
RG 326	U.S. ATOMIC ENERGY COMMISSION
Collection	1320
Box	16 - Palomares
Folder	21 - Correspondence, Richmond

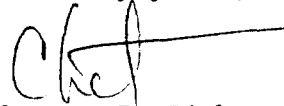
Dear Martin:

together

I am sending under separate cover a copy of trip report covering my travel to Madrid and Palomares earlier this year. The package contains copies of ten papers, some of which I had translated from Spanish and French, which treat some aspect of the Palomares accident. I trust you will see that these are properly stored in the DBER Project Indalo file so that they can be made available when needed. I have also sent a complete set of the reports plus my trip report to Gordon Facer in DMA.

Best personal regards.

Sincerely yours,



Chester R. Richmond
Alternate Health Division Leader

CRR:ES

Sep. cover - encls. a/s

CC:J. L. Liverman - DBER

Enc. trip report only

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OFFICE MEMORANDUM

TO : P. F. Belcher - ADLL

DATE: August 6, 1974

FROM : C. R. Richmond 

SUBJECT: TRIP REPORT ON FOREIGN TRAVEL TO SPAIN
(FEBRUARY 23-MARCH 4, 1974)

SYMBOL : H-DO

Environmental contamination from plutonium in places such as Rocky Flats, Colorado, Mound Laboratory in Ohio, Thule, Greenland, Palomares, Spain, and the Bikini and Eniwetok Atolls of the Pacific has generated much concern throughout the scientific community. In addition to the need to learn more about these specific cases of environmental contamination, it is possible that we may deduce information that may be more helpful in the more general sense as regards environmental contamination arising from plutonium released from the nuclear fuel cycle associated with electrical power production or satellites using plutonium as a heat source. The incident at Palomares, Spain, in 1966 which resulted from an accident involving nuclear weapons created considerable international attention as it involved plutonium contamination of the general public in a foreign country. Since the accident on January 17, 1966, there has been interaction between the United States Atomic Energy Commission and the Spanish Government which has involved visits to Spain by members of the AEC staff and contractor personnel, especially from the Los Alamos Scientific Laboratory.

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The initial interaction between the United States and Spain resulted in an agreement between the United States and the Spanish Atomic Energy Commission which set up a four-point follow-up program designed to collect additional information on the Palomares accident. This program was to be conducted under the direction of the Junta de Energia Nuclear, Division de Medicina y Protection (under the guidance of Dr. Eduardo Ramos), with equipment, technical help, and operational support supplied by the U. S. Atomic Energy Commission. The four-point follow-up program included the following: (1) collection of information on the uptake and retention of plutonium and uranium by representative members of the population group who were potentially exposed to plutonium oxide by inhalation; (2) measurement of the temporal and seasonal fluctuations in the plutonium air concentration above the plutonium oxide-contaminated agricultural area that had been subjected to the decontamination procedures following the accident; (3) serial measurements of contamination levels (both by plant uptake from the soil and by wind dispersal) of agricultural products produced in the contaminated area subsequent to decontamination; and (4) studies of the temporal migration and redistribution of plutonium oxide in soil, decontaminated by deep plowing as a result of continued cultivation and weathering processes.

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Technical assistance amounting to approximately \$250 000 in the form of equipment, which included a whole-body and a chest counter, plus annual operating funds to the extent of approximately \$25 000 per year have been provided by the U. S. Atomic Energy Commission to further support the follow-up effort. In the fall of 1971, Dr. W. H. Langham of the LASL traveled to Palomares and Madrid to visit the scene of the accident some 6-1/2 years later and to hold technical discussions with Drs. Eduardo Ramos and Emelio Iranzo and other members of the Junta's technical staff. Dr. Langham's report contained the following recommended actions to the AEC: (1) encourage the Junta to publish their observations and data related to the accident; (2) increase operational support to the Junta to provide more technical staff; (3) update the equipment used by the Junta and provide at least one additional alpha spectrometer; (4) reevaluate their approaches to the four points of the agreement and modify them as indicated by the six years of experience and accumulated information since the time of the accident; (5) consider the advisability of providing the Junta with a lung counter to recount some of the Palomares residents who were examined during the first year following the accident; and (6) manifest more interest in the work of the Junta through more review of their efforts.

Dr. Langham's recommendations resulted in a renewed interest on the part of the AEC in obtaining more information on the Palomares accident. Unfortunately Dr. Langham was killed in an aircraft accident in May 1972, less than three months after his report was written. In early June, Dr. Ramos in a letter to Dr. H. D. Bruner of the AEC outlined some of the more pressing equipment needs of the Junta for use in Project Indalo. This ultimately led to my involvement and that of others here at the LASL in assisting the Junta via AEC Headquarters in updating equipment used at Palomares and Madrid in revitalizing the research and development program associated with Project Indalo. During FY 1974, the AEC/DBER made available \$27 000 capital equipment funds to be used for capital equipment for Project Indalo. It was our responsibility to obtain the necessary equipment and, if necessary, to assemble and test the equipment prior to sending it to the Junta in Madrid. My trip to Spain earlier this year was to visit Palomares and Madrid and to assist the scientific personnel at the Junta in developing future plans for Project Indalo. Subsequently the equipment was shipped to Madrid, and Mr. P. N. Dean of the LASL Health Division journeyed to Madrid in June 1974 to oversee the installation of the purchased equipment at the Junta in Madrid. We have not supervised the installation of equipment to be used in the field at Palomares.

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The remainder of the report will discuss my observations and recommendations in terms of two general areas: (1) the four-point plan developed between the United States and the Spanish Atomic Energy Commission, and (2) the six recommendations made by Dr. Langham following his 1971 visit to Spain.

FOUR-POINT AEC/JEN PROGRAM(1) Collection of Information on Uptake and Retention of Plutonium and Uranium by Representative Members of the Population Group Potentially Exposed to Inhalation of Plutonium Oxide

After the accident in 1966, 100 of the most likely exposed residents of Palomares were taken to Madrid and counted over the chest region by means of a proportional counter. The lower limit of detection was approximately 40 nanocuries, and no positive activities were determined in any of the measured individuals. The detector was later modified by the Spanish to give a minimum detectable limit of about 16 nanocuries, and several of the individuals who might have received higher exposures than others were recounted. No positive measurements were observed even with the improved detector sensitivity. Forty-nine of the subjects were males over 14 years of age, 32 were females over 14 years of age, 10 were males under 14 years of age, and 9 were females less than 14 years of age. Measurements were made at the laboratories of the Division de Medicina y Protección de la JEN in Madrid. Prior to counting, the subjects underwent a complete medical examination in order to determine their state of health.

Twenty-four hour urine samples were collected from the same 100 individuals during their stay in Madrid. Three complete 24-hour urine samples were taken from each subject on three consecutive days. Alpha spectrometry was used to determine the plutonium-239 content of the urine. Seventy-one percent of the subjects showed no indication of urinary plutonium. Eighteen percent showed, in some of the analyses, plutonium contents of less than 0.1 disintegration per minute per 24-hour sample, and 9 percent showed activity levels between 0.2 and 0.1 disintegration per minute per 24-hour sample and 2 percent levels between 0.2 and 1.0 disintegration per minute in the 24-hour urine samples.

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My discussions with Drs. Ramos and Iranzo confirmed our earlier belief that no further whole-body or urine measurements for plutonium-239 have been made on the Palomares residents since those reported above. The new detector system which was provided to the JEN earlier this year is now in working condition, and measurements have been made using appropriate radioactive standards within a REMAB phantom. The new detector is of the dual phoswich crystal (sodium iodide and cesium iodide) type which will allow the detection of approximately 7-8 nanocuries plutonium-239. The equipment also includes an echo encephalograph to permit accurate estimation of the subject's chest thickness. The JEN personnel would like to obtain additional measurements on some of the Palomares residents and perhaps some of the civil guards who were associated with the 1966 accident to see if any plutonium can be detected. If arrangements can be made to this end, small family groups would be brought to Madrid and measured at the JEN. At that time urine samples could be obtained and medical examinations carried out.

The paper by Odland et al. which is included in the bibliography to this report is of interest in this respect. The Odland paper contains information on plutonium-239 in the urine of military personnel who assisted in the cleanup following the 1966 accident at Palomares. Odland in his article states: "Department of Defense pathologists have been alerted to the desirability of collecting as much pulmonary and thoracic lymphatic tissue as possible from all individuals who worked in Spain on this project and have come to autopsy. This material will be studied in an attempt to relate lung deposition with urinary excretion. All information collected on this project has been placed on key punch cards, and is readily available for recall and manipulation by electronic data processing equipment. The file on the bioassay support of the Palomares incident is permanent." One of the military personnel reported by Odland died on October 28, 1966, of acute myocardial infarction. A 7.8-gram (wet weight) section of the lung contained approximately 2.8 picocuries of plutonium-239. If the plutonium were homogeneously distributed throughout the entire 950-gram lung, the total activity would be 336 picocuries or 0.34 nanocurie, an amount too small to be accurately detected by the chest counter currently installed in Madrid (or, for that matter, any other external detectors currently used to detect plutonium in man).

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(2) Measurement of Temporal and Seasonal Fluctuations in Plutonium Air Concentrations above a Plutonium Oxide-Contaminated Agricultural Area that Has Been Subjected to the Agreed upon Contamination Procedures

This point of the agreement resulted in the installation of four continuously operating air monitoring stations and two meteorological stations which were strategically located with respect to the contaminated area. One of the air monitoring and meteorological stations was located in the center of Palomares in Area 5 (see attached map of Palomares). Continuous air monitoring at all four stations was continued for several years following their installation. Daily samples were counted for gross alpha activity, and 10-day samples were pooled and analyzed for plutonium using alpha spectrometric techniques. Uranium-234 and uranium-235 were determined in the 1967 air samples. These data were reported by Iranzo and Salvador at the Second International Congress on Radiation Protection held at Brighton, England, in May 1970. A preprint of this information has been widely distributed throughout the scientific community, but it has not yet been published. The complete reference to this work is contained in the bibliography attached to this report. A cursory examination of the data given in the Iranzo and Salvador report suggests a resuspension factor of the order of 10^{-6} for the worst (windy) conditions reported. This is an example of the kinds of information that could be deduced from a careful and thorough workup of data obtained to date on the Palomares incident.

Positive measurements were obtained occasionally for air samples collected at all stations, with the highest values coinciding with those periods of high wind velocity (above 35 kilometers per hour). For 1966 and 1967, the mean plutonium-239 values in Palomares were 0.38×10^{-15} and 0.09×10^{-15} microcuries per cubic centimeter, respectively. Dr. Langham, in his 1972 report, indicated that only the air sampling

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station in the center of the village (Area 5) and the one in the irrigated fields to the east (Area 3) were in operation. The others had been discontinued, and parts had been salvaged to keep the surviving two in operation. Langham reported that, judging from the sound, the remaining two were about to cease operation. Although they were still in operation at the time of my visit, I am certain they were in poorer condition than in 1971. In addition, hedges near the air sampler in Area 5 had grown considerably and very probably blocked the air samplers from materials carried by air from Impact Point 2 west of the village. This is a very unfortunate situation, as the air sampler at Station 2-2 was located so as to sample wind pickup and movement of plutonium from the untreated hillsides near Impact Point 2.

COMMENTS ON ACTIONS RECOMMENDED BY LANGHAM IN 1972

(1) Encourage the Spanish to Publish Their Observations to Date

I feel that it is extremely important to have a major publication on the "Palomares story" that will reach large segments of the scientific community and, in time, the general public. The temptation is to preserve the status quo and not stir the water, but the story of Palomares should be told in these days of almost paralyzing fear of plutonium on the part of some members of the public. A considerable amount of information on the Palomares subject has appeared in print since 1966, but very often the reports are difficult to obtain. During my visit, I obtained several papers in Spanish and French which had been prepared by the JEN technical staff. The references attached to this report represent the bulk of the reports available on the subject.

The Hall-Otero agreement states that any publications should be jointly approved by the United States and Spain, and this constraint has been interpreted by some as one reason that a major publication has not been prepared. I do not believe this to be true. Drs. Ramos and Iranzo discussed this topic with me in some detail, and I believe we all agree on the need for a report in a widely read scientific journal. There are several possibilities which could be explored, and I have informally offered any assistance I could provide to Drs. Ramos and Iranzo should a decision be made to prepare a report.

(2) Increase Operational Support to Provide More Technical Staff

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I believe the AEC support of about \$25 000 per year was temporarily interrupted but is now in force once again. Technical support of Project Indalo is important and should be continued actively by both the AEC and the JEN. The information that will accrue in time from Project Indalo will certainly be well worth the relatively small investment.

(3) Update Their Equipment and Provide at Least One Additional Alpha Spectrometer

This has been done, as indicated earlier, with FY 1974 funds made available by AEC/DBER. It is important, however, that we do not allow the equipment to fail as was the case of the two air samplers in Palomares. I suggest that additional funds be made available, as needed, by the AEC or the JEN to prevent such re-occurrences. We have developed an equipment list (approximately \$15 000) of items which could be used in Project Indalo. The JEN personnel are willing to spend some of their money for new equipment if we recommend their doing so. However, I would do so only if the items could be purchased in Spain, as there are many difficulties involved in getting materials into Spain through normal channels. I also suggest that any future shipments be made through either the United States Embassy in Spain or via Torrejon Air Force Base. This would also be a great help to the JEN personnel.

The equipment includes a programmable calculator; standard radioactive sources of uranium-234, uranium-235, plutonium-238, plutonium-239, and americium-241 for energy calibration (absolute activity not required); four additional channels for alpha spectrometry; 50-volt power supply for alpha spectrometer, equipment rack, and grounding bus; modern portable oscilloscope; HV adaptor box; coupling fluid for the echo encephalograph, etc. Perhaps as important is the need for technical liaison, which will be discussed below.

(4) Reevaluate Their Approaches to the Four Points of the Agreement and Modify Them as Indicated by the Past Six Years of Experience and Accumulated Data

The four points of the agreement are still basically sound and need not be altered. Unfortunately many of the measurements needed have not been made because of the lack of certain pieces of equipment (alpha spectrometers) or the failure and non-replacement of others (air samplers). I discussed this with JEN personnel, and they are enthusiastic and would like to "renew" the effort. It is time to begin selective sampling of domesticated animals at Palomares (we observed goats grazing throughout the contaminated area near Impact Point 2 west of the village) which are consumed by people. I also believe more work should be initiated on plutonium-239 measurements in snails, rodents, and lizards at selected locations in Palomares. I have sent information to JEN personnel on techniques for plutonium-239 analysis of tissues and methods for using plutonium-242 as an analytical tracer (better than the plutonium-236 that is currently used).

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As indicated earlier, additional measurements of urine samples are needed, as are chest measurements of some Palomares residents. I believe Drs. Ramos and Iranzo have established the necessary rapport with the Palomares residents and can probably convince the residents to participate in such an effort with little fanfare.

(5) Consider the Advisability of Providing Them with a New Lung Counter to Recount a Number of the 100 Palomares Residents Examined the First Year after the Accident

The dual crystal (NaI-CsI) phoswich detectors have been installed in Madrid, and calibration measurements are in progress. Dr. Langham suggested that the minimum detectable activity (MDA) might be 4 ± 4 nanocuries plutonium-239, but a value of 7-8 nanocuries is more likely. The MDA for americium-241 will be about 0.3 nanocurie. Since the United States is committed to an assistance program, I believe we should offer the best available equipment, technology, and expertise as we are, in a sense, "on display" to many European scientists who visit the JEN.

(6) Manifest More Interest in Their Work through More Review of Their Efforts

I strongly concur with this suggestion. The ultimate success or failure of Project Indalo (in terms of accruing valuable information on plutonium in the environment or merely accumulating numbers) may depend on this point. The Spanish investigators are competent and proud, but it is necessary for them to maintain strong links with investigators in the United States. There has been correspondence between several US contacts and JEN personnel, but there is a need for better liaison and information exchange.

I believe the AEC needs a primary technical contact in the United States who can assist the JEN personnel in technical matters and who can help make the needs of the JEN known in Washington. Further, I recommend that this person, or someone familiar with Project Indalo, visit the JEN on an annual basis. Because of communications problems, there is no substitute for an actual visit.

GENERAL COMMENTS

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During my trip, I visited Palomares and took many photographs. Copies were sent to Dr. Ramos, and one set will be sent to AEC/DBER when properly indexed. The area which lies between the village and the Almanzora River bed is heavily cultivated and, at the time of my visit, was very lush. It is difficult to believe that a nonnuclear weapons accident took place in this area in 1966. These photographs include the major impact sites and the test plots from which soil and vegetation samples are taken. They also give some indication of the areas used for grazing by the goats (Area 2) which may be a source of animal tissue for plutonium-239 monitoring.

During 1973, some severe flooding occurred throughout the south of Spain, and the normally dry Almanzora River flooded rather dramatically. Many lives were lost in the south of Spain, although not in the immediate vicinity of Palomares. I

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suspect that the Area 3-2 sampling station was completely removed and washed into the Mediterranean. Many of the cultivated areas were destroyed and were still being reestablished during my visit. This severe natural event may well have been more damaging and stressful than the 1966 accident to the people of Palomares.

The Palomares area experienced a rather severe drought for some years following the 1966 accident but currently is enjoying better agricultural conditions. These cycles of relative dryness are known to occur in the Palomares area, but there is some speculation that the recent dry period may have been an indirect result of the 1966 accident. Much water was used to wet the ground after the accident to reduce airborne contamination, especially during the removal of contaminated soil which was removed and sent to the United States for disposal. Some of the JEN personnel think that the water table may have been drastically reduced and not recharged until recent years when considerable rainfall occurred to the north. This is only speculation but may give us some insight as to how to proceed in future accidents that might occur. For example, in fragile arid areas one might consider means other than local water supplies to reduce airborne contamination.

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Translations of articles published by JEN personnel have been obtained and are available as LASL translations. A complete set of the references contained in this report and data obtained during my visit will be transmitted to AEC/DBER and to the Director of LASL.

C. R. Richmond
C. R. Richmond

CRR:ES
Encs. a/s

8-13-74

CC:G. C. Facer - DMA

M. L. Minthorn, Jr. - DBER

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Plutonium isopleths -- Palomares, Spain.

AREA 2

AREA 5

AREA 3

